Space Weather Technical Forecast

Issued on Monday, 17 April 2023 at 00:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts), and a slight chance of X-Class flares (R3 strong radio blackouts) throughout. Increasing chance of G1/Minor Storms 19-20 Apr with a slight chance of G3/Strong Storms on the 20 Apr due to possible CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with only C-class flare activity from a number of different regions and a region beyond the northeast limb has recently produced a significant C-class flare. There are 11 regions on the visible disc. AR3280, 3281 and 3282 have all stabilised or declined in size slightly after recent rapid development. All three of these regions however are still demonstrating a high level of complexity. AR3279 has increased in classification slightly after a period of decline. The new region to the southeast of AR3281 has now been numbered AR3283 and is starting to show development and increased complexity, now classified as Cri/Beta-Gamma. The remaining regions tend to be simple or are following a slow evolution.

Three notable CMEs have been analysed for potential Earth impacts over the last 24 hours. A large filament liftoff observed in the northern hemisphere approximately 15/1100UTC has been analysed and may glance the Earth on 19 Apr. A filament eruption from the southwest at 15/2250UTC was assessed and appears to be directed away from Earth. The third eruption, a long period filament eruption from the northwest disk around 15/2330UTC produced a near full halo with an estimated arrival sometime on day 4 (20 Apr). No other Earth directed CMEs detected in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind observed by ACE/DSCOVR at L1 has generally been slow at below 400km/s throughout with density also below average. Total magnetic field strength, IMF, was weak around 6-7nT, with the north-south component, Bz, also varying weakly beteen +6/-5nT. Phi angle was predominantly weakly positive (away from the Sun), with frequent fluctuations into the negative sector. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a flat trend, with 1.31e6 integrated pfu observed at 17/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, with a likelihood of Moderate activity through the next four days. There is a slight chance of isolated X-class flare activity.

Solar Wind / Geomagnetic Activity: Geomagnetic activity is forecast to be mainly Quiet to Unsettled through days 1 and 2 (17, 18 Apr) with solar winds at background levels. Into days 3

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and 4 (19, 20 Apr) There is an increasing risk of Active or G1/Minor Storm intervals, with a slight chance of G2-G3/Moderate-Strong storm intervals by day 4 (20 Apr) due to forecast CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels, although there is a slight chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere. High energy (greater than 2 MeV) electron flux is currently at background levels throughout the period. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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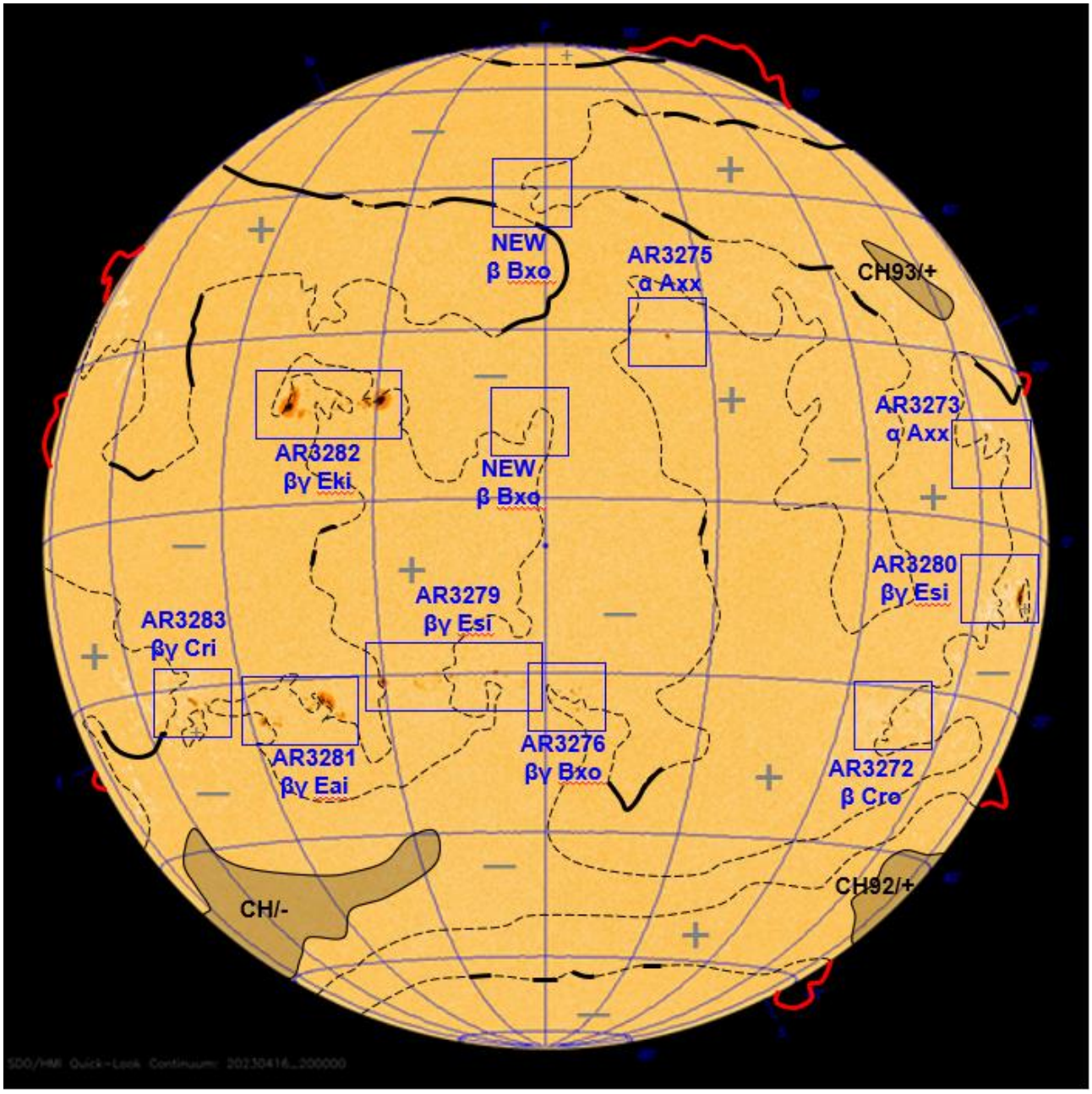
Figure 1. Solar Analysis Valid 16/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Three potentially significant CME eruptions occurred on 15 Apr. A partial halo from a filament eruption in the north at 15/1120UTC has been modelled and may glance the Earth on 19 Apr. A faster filament eruption observed from the southwest disk around 15/2250UTC appears to be directed away from Earth. The third eruption, a long period filament eruption from the northwest disk around 15/2330UTC produced a near full halo with an analysed speed of 340km/s, MOSWOC Enlil model is currently predicting an estimated arrival some time on day 4 (20 Apr). No other potential earth directed CMEs detected in available imagery.

Outside any CME influence the near-earth environment appears benign, with winds at background and no further coronal holes forecast to connect with the Earth during the period. A CME which left the Sun on 12 April did have the potential to glance the Earth during the 16 Apr, but no significant arrival has been observed.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through days 1 and 2 (17, 18 Apr). Into days 3 and 4 (19, 20 Apr) There is an increasing risk of Active or G1/Minor Storm intervals, with a slight chance of G2-G3/Moderate-strong storm intervals by day 4 (20 Apr) due to expected CME arrival.

Geo-Magnetic Storm / Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	20	40
Strong	G3	No	1	1	1	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0550	Partial Halo	Filament eruption	NW Quadrant	250 km/s	19/1200 UTC	Low confidence. Limited Impacts expected.
16/1343	Near full Halo	Filament eruption	NW Quadrant	342 km/s	20/1800 UTC	Medium confidence.

Figure 2: Latest ENLIL ensemble output

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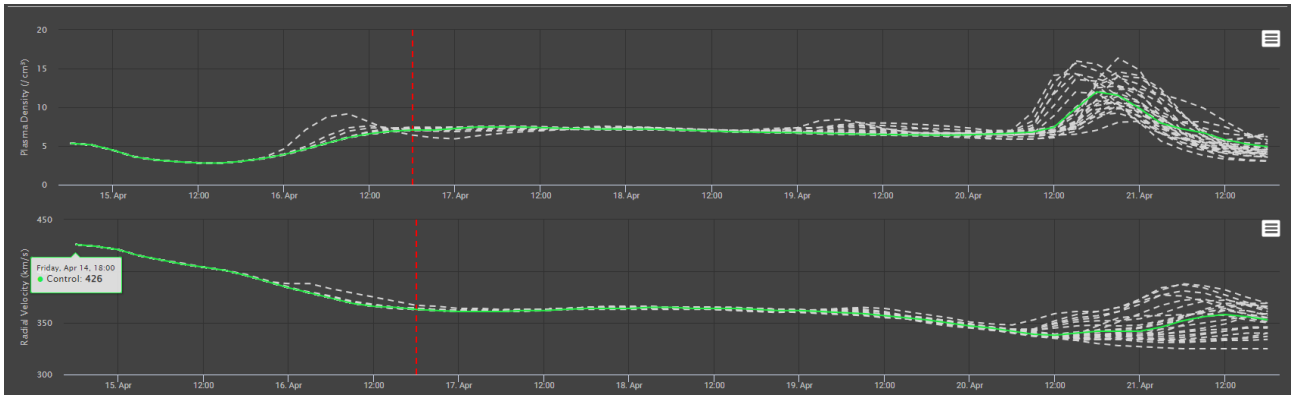

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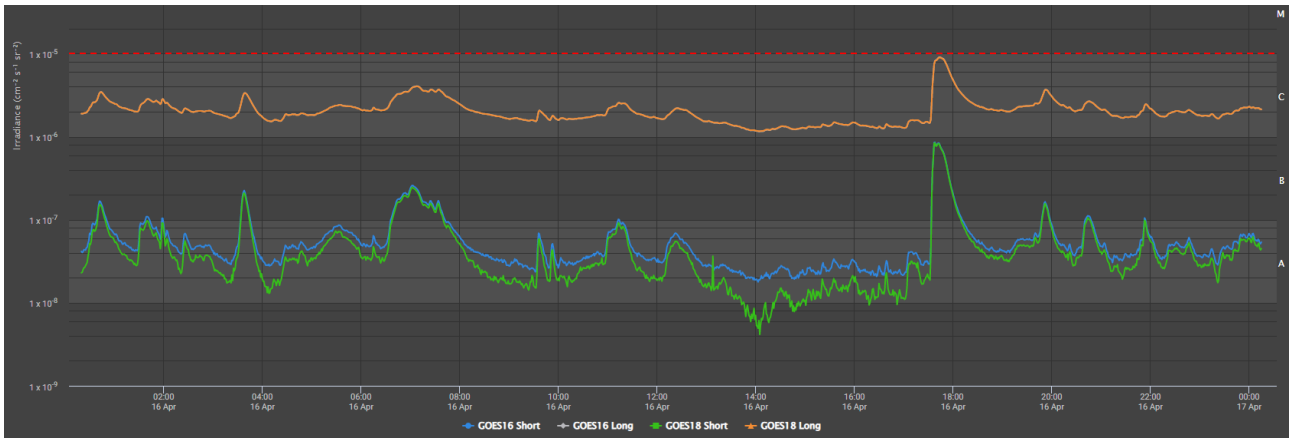
Radio Blackouts - X-Ray Flares:
The current mainly Low to Moderate solar activity is forecast to continue through the next four days given the number of active regions on the visible disk, with isolated M-Class flares likely based on current sunspot configurations. Based on the magnetic complexity of the larger sunspot groups there is also a slight chance of X-class flaring, and we maintain the risk even as we lose AR3280 around the western limb into days 1 and 2 (17-18 Apr), with potential for two notable regions to rotate from the far side based on analysis of helioseismology and SDO imagery. Further analysis of these regions will take place as and when they rotate onto the visible disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: 24hr X-ray trace from GOES 18.



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period.

AR3280 carries the greatest risk of a proton event early in the period, with a continued high level of magnetic complexity as it rotates across the western hemisphere. A number of complex regions in the east could produce some proton response from particularly energetic events, with these acting to maintain the risk into the period as they rotate westward.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater then 2MeV) is at background levels and is likely to remain muted in a benign solar wind environment with no significant high speed stream effects expected. The British Antarctic Survey Radiation Belt Model (BAS-RBM) is forecasting a similarly muted environment. Any inputs from CME effects may have a neutral effect in the short term, considering the balance between an increase in any geomagnetic activity and input of material into the radiation belts.

The associated electron fluence forecast is well below the Active (1e8 integrated pfu) threshold and is expected to remain so during the forecast period. MOSWOC REFM is forecasting a slightly rising trend in fluence for the next four days, viewed as good guidance.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	1	5	1
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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